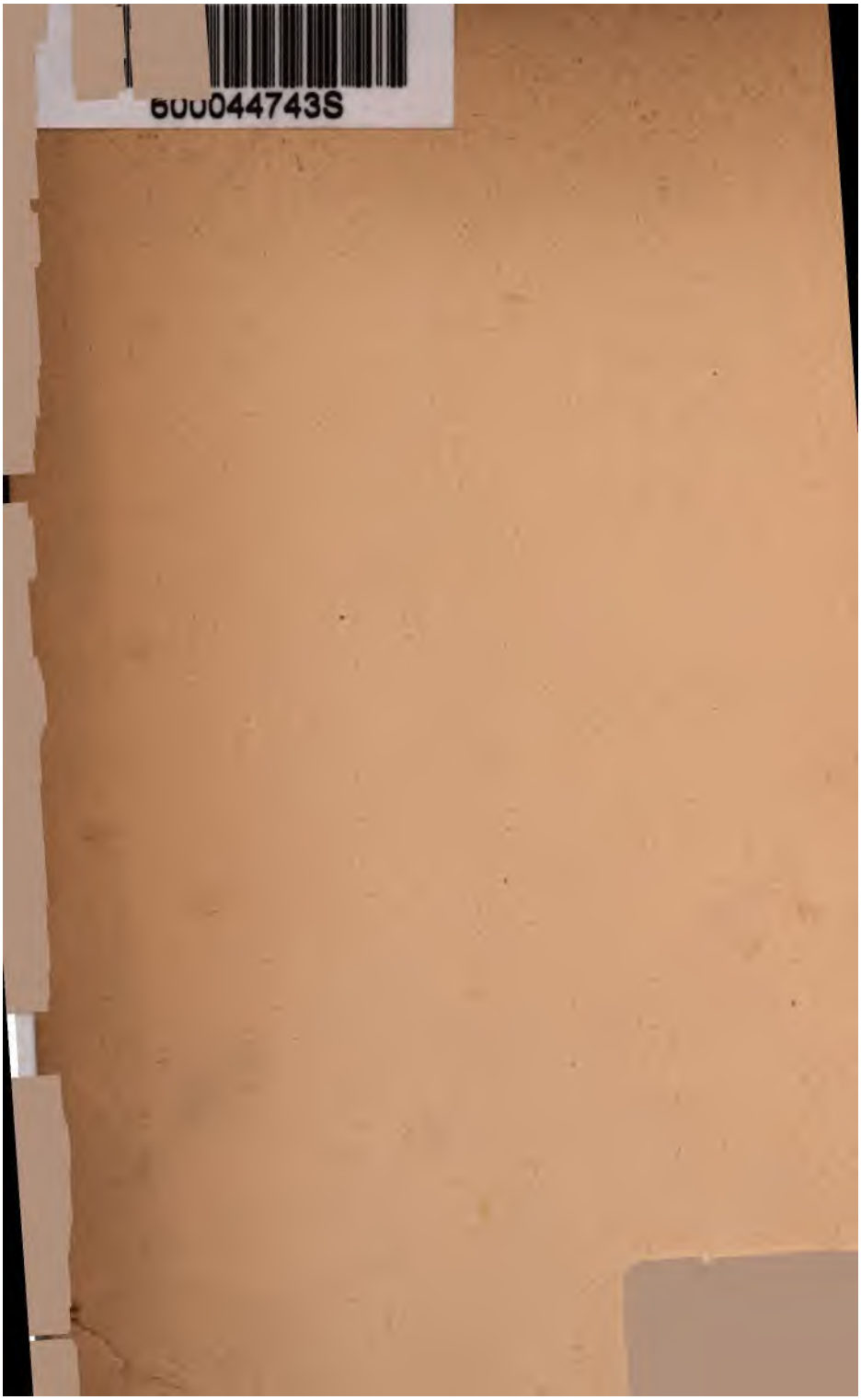

SYLLABUS

OF

LECTURES ON ZOOLOGY AND GEOLOGY,

AND OF THE

THOMSONIAN LECTURES ON MINERALOGY,

FOR THE USE OF

STUDENTS ATTENDING THE NATURAL HISTORY CLASS IN THE UNIVERSITY OF EDINBURGH.

BY

GEO. J. ALLMAN, M.D. DUB. & OXON.,
F.R.C.S.I., F.R.SS. L. & E., M.R.I.A.,
HON. MEMBER OF THE ZOOLOGICAL SOCIETY OF LONDON, HON. MEMBER OF THE ROYAL GEOLOGICAL SOCIETY OF CORNWALL, AND OF THE IMPERIAL RL. SOCIETY OF ZOOLOGY AND BOTANY OF VIENNA, REGIUS PROFESSOR OF NATURAL HISTORY, AND REGIUS KEEPER OF THE NATURAL HISTORY MUSEUM.

EDINBURGH:
PRINTED BY NEILL & COMPANY.
MDCCCLXVII.


27.6.1915
LIBRARY

SYLLABUS.

The Scope and Object of NATURAL HISTORY.

The three great kingdoms of Nature—the ANIMAL, the VEGETABLE, and the MINERAL—considered differentially.

Differences between organised and unorganised bodies.

These differences chiefly referable to

1. Intimate structure.
2. General configuration.
3. Chemical composition.
4. Mode of increase.
5. Cyclical change.

That department of knowledge which has for its subject the nature and laws of living beings is termed BIOLOGY.

Division of Organised Bodies into PLANTS and ANIMALS.

Great difficulty of drawing a well-marked boundary-line between the Animal and Vegetable Kingdoms.

Examination of the value to be attributed to the differences supposed to be contained in the following alleged facts.

1. Possession of a *mouth* and *stomach* by Animals, and their absence from Plants.

2. Larger amount of *nitrogenous principles* in the tissues of Animals than in those of Plants.

3. *Sensation* and *voluntary motion* as exclusive attributes of Animals.

4. The food of Plants consists of *inorganic* matter; that of Animals, of matter already *organised*.

5. *The reaction* of Animals *upon the atmosphere* characterised by the production of carbonic acid; that of Plants by the liberation of oxygen.

Comparison of animal forms with the view of finding more general expressions for the multitude of particular facts presented by these forms.

Living beings admit of being studied under three principal aspects—the *Morphological*, the *Physiological*, and the *Distributional*.

Hence *Botany* and *Zoology*, the two great sections comprehended under Biology, admit each of being divided into three departments:—MORPHOLOGY, which treats of *form*; PHYSIOLOGY, which treats of *function*; and DISTRIBUTION.

Animals, regarded Morphologically and Physiologically, differ from one another in two fundamental points:—

1. Specialisation of Function.
2. Morphological Type.

HOMOLOGY and ANALOGY defined and illustrated.

Philosophical Classification is a comprehensive expression of the facts and laws of Morphology and Physiology.

Impossibility of arranging the Animal Kingdom in a continuous series leading uninterruptedly from the simplest to the most complex animal form.

Von Bär's Law.—*The progress from the General to the Special in Development.*

SYMMETRY of Animal Forms. The MEROSOME or Ideal Element of Form.

Symmetry is the result of the regular repetition of the same element of form.

BILATERALISM or Pleuromeric Symmetry. Bilateralism conditioned by a determinable median antero-posterior and dorso-ventral plane.

RADIALISM or Spheromeric Symmetry.

ZONALISM or Orthomeric Symmetry.

Radialism and Zonalism may be each combined with Bilateralism.

The *Six great plans* of Structure recognisable in the Animal Kingdom:—

1. **PROTOZOA.**
2. **CŒLENTERATA.**
3. **ECHINOZOA.**
4. **MOLLUSCA.**
5. **ANNULOSA.**
6. **VERTEBRATA.**

These groups constitute the Primary Divisions or Sub-King-

doms, and each is further divisible into groups of greater and greater speciality, according to the following series :—

KINGDOM.
SUB-KINGDOM.
CLASS.
ORDER.
FAMILY.
GENUS.
SPECIES.

[In the following arrangement of the sub-kingdoms, classes, and orders of animals, extinct groups are indicated by an asterisk prefixed to the name.]

I.

PROTOZOA.

Animal monomeric, or showing no composition out of merosomes ; no determinable median plane ;[1] no definite body-cavity, for the most part of microscopic size, with no obvious differentiation of the body into tissues and organs.

The Protozoa are divisible into the following four Classes :—

1. GREGARINÆ.—Parasitic cell-like bodies, destitute of mouth, and incapable of emitting pseudopodia.

Orders of Gregarinæ.

1. *Monocystidea.*—Ex. Monocystis.
2. *Gregarineæ.*—Ex. Gregarina.

2. RHIZOPODA.—Body consisting of sarcode, destitute of mouth, and capable of emitting extensile and retractile prolongations of its substance (pseudopodia).

Orders of Rhizopoda.

1. *Amœbea.*—Ex. Amœba, Difflugia.
2. *Foraminifera.*—Ex. Rotalia, Polystomella, *Nummulites, *Eozoon.
3. *Radiolaria.*—Ex. Thalassicolla, Encyrtidium.
4. **Graptoliteda.*—Ex. Didimograpsus, Graptolithus.

[1] The PROTOZA often form compound colonies (*e.g. Foraminifera*) which may imitate the symmetry of the other sub-kingdoms, without any violation of the diagnosis here given.

3. Spongiæ.—Sarcode bodies, destitute of mouth, and united into a composite mass, which is traversed by canals opening on the surface, supported almost always by a framework of horny fibres or of silicious or calcareous spicula.

Orders of Spongiæ.

1. *Halisarcina.*—Ex. Halisarca.
2. *Sponginæ.*—Ex. Sponges of Commerce (Spongia).
3. *Halichondrinæ.*—Ex. Halichondria.
4. *Calcispongiæ.*—Ex. Grantia.
5. **Petrospongiæ.*—Ex. Ventriculites, Siphonia.

4. Infusoria.—Body with a distinct mouth; incapable of emitting pseudopodia; locomotion by vibratile cilia or lash-like appendages.

Orders of Infusoria.

1. *Suctoria.*—Ex. Acineta, Podophyra.
2. *Ciliata* —Ex. Bursaria, Paramœcium, Vorticella.
3. *Flagellata.*—Ex. Peridinium, Astasia.

Nature and properties of sarcode.
Examination of the doctrine of spontaneous generation.
Geological distribution of the Protoza.

II.

CŒLENTERATA.

Animal composed of numerous merosomes which are disposed radially round a longitudinal (antero-posterior) axis; frequently with a determinable median antero-posterior and dorso-ventral plane (bilateral); a distinct body-cavity which always communicates with the outer world through the mouth.

The Cœlenterata are divisible into the following two Classes:—

1. Hydrozoa.—No stomach-sac differentiated from the general body-cavity.

Orders of Hydrozoa.

1. *Hydroida.*—Ex. Tubularia, Sertularia, *Oldhamia?
2. *Siphonophora.*—Ex. Diphya, Agalmopsis, Portuguese man-of-war (Physalia).
3. *Lucernarida.*—Ex. Lucernaria, Carduella.
4. *Discophora.*—Ex. Aurelia, Cyanea, Pelagia.
5. *Ctenophora.*—Ex. Beroe, Cydippe.

2. ACTINOZOA.—A stomach-sac suspended in the body-cavity, and freely opening into it; the stomach-sac connected with the body-walls by radiating lamellæ.

Orders of Actinozoa.

1. *Zoantharia.*—Ex. Sea anemones (Actinia), Star-corals (Astræa), Bram-corals (Meandrina).
2. *Alcyonaria.*—Ex. Dead man's toes (Alcyonium), Sea pens (Pennatula), Sea rods (Virgularia), Red coral (Corallium), Fan coral (Rhipidogorgia).
3. **Rugosa.*—Ex. Cyathophyllum, Favosites.

Nature of Coral.—Sclerodermic and Sclerobasic Corals.

Coral Reefs, their formation and geographical distribution.

Darwin's classification of Coral Reefs into Atolls, Lagoon Islands, and Barrier Reefs.

Sexual and non-sexual reproduction.

Alternation of generations.

The ZOOID.

The Biological INDIVIDUAL.

Phenomenon of Phosphorescence of the Sea.

Geological distribution of the Cœlenterata.

III.

ECHINOZOA.

Animal composed of numerous merosomes, which are disposed radially round a longitudinal axis; always with a determinable median antero-posterior and dorso-ventral plane; a distinct body cavity, from which the alimentary canal is entirely shut off, and which, therefore, never communicates with the outer world through the mouth.

The Echinozoa admit of being divided into the following two Classes:—

1. ECHINODERMATA.—Integument (perisome) more or less completely calcified by the deposition of calcareous particles; a peculiar system of tubes (ambulacral system) into which water is admitted from without, and which is partly developed into tubular feet (ambulacra), protrusible by the injection of water.

Orders of Echinodermata.

1. *Crinoidea.*—Ex. Feather-stars (Comatula Pentacrinus), *Lily-stars (Encrinus, Platycrinus), *Cystidians (Hemicosmites, Sphæronites), *Blastoideans (Pentatremites).
2. *Asteroidea.*—Ex. Star-fishes (Asteracanthion, Solaster), Sand stars (Ophiura, Ophiolepis), Medusa-head stars (Asterophyton).
3. *Echinoidea.*—Ex. Sea urchins (Echinus, Spatangus, Clypeaster, *Palæchinus).
4. *Holothuroidea.*—Ex. Sea cucumbers (Holothuria).

2. SCOLECINÆ.—Soft-bodied, cylindrical or flattened animals, destitute of aquiferous protrusible appendages for locomotion.

Orders of Scolecinæ.

1. *Platyelmia.*—Ex. Tapeworms (Tænia), Flukes (Distoma), Planariæ.
2. *Nematelmia.*—Ex. Echinorynchus, Ascarides (Ascaris, Oxyuris).

Geological distribution of the Echinozoa.

IV.

ANNULOSA.

Animal composed of numerous merosomes, which are disposed in zones along a longitudinal axis; a determinable median antero-posterior and dorso-ventral plane; neural and hæmal regions not shut off from one another.

The Annulosa are primarily divisible into the two following Series:—

1. ANARTHROPODA.—Body destitute of jointed appendages.
2. ARTHROPODA.—Body provided with jointed appendages.

The three following Classes are included under the section Anarthropoda:—

1. GEPHYREA.—External segmentation not obvious; a ventral more or less distinctly segmented nerve-cord.

Orders of Gephyrea.

1. *Priapulidea.*—Ex. Priapulus.

2. *Sipunculidea.*—Ex. Spoon-worms (Sipunculus).
3. *Echiuridea.*—Ex. Echiurus, Bonellia, Sternaspis.

2. ROTIFERA.—External segmentation more or less distinct; head provided with one or more ciliated locomotive discs; a cephalic ganglion with radiating nerve-threads.

Orders of Rotifera.

1. *Gasterodela.*—Ex. Notomata.
2. *Enterodela:*—Ex. Brachionus, Hydatina, Floscularia.

3. ANNELIDA.—Body with distinct external segmentation; a ventral double ganglionated nerve-chord.

Orders of Annelida.

1. *Discophora.*—Ex. Leeches (Hirudo, Clepsine).
2. *Oligochæta.*—Ex. Earthworms (Lumbricus).
3. *Tubicola.*—Ex. Tubeworms (Terebella, Sabella, Serpula, *Serpulites, *Microconchus).
4. *Nereidea.*—Ex. Sandworms (Arenicola, Nereis, Aphrodite).

Under the Arthropoda are included the remaining four Classes:—

4. CRUSTACEA.—Respiration by gills or by the general surface of the body; two pairs of antennæ; feet borne by the thorax, and usually also by the abdomen.

Orders of Crustacea.

1. *Cerripedia.*—Ex. Barnacles (Lepas), Acorn shells (Balanus).
2. *Entomostraca.*—Ex. Cyclops, Notodelphys, Fish-lice (Argulus, Caligus, Cecrops, Lernæa).
3. *Branchiopoda.*—Ex. Water-fleas (Daphnia), Cypris, Estheria, *Beyrichia, *Dithyrocaris, *Trilobites (Calymene, Phacops, Paradoxides, Trinucleus), *Eurypterus, *Pterygotus.
4. *Pœcilopoda.*—Ex. King crabs (Limulus), *Bellinurus.
5. *Isopoda.*—Ex. Wood-lice (Oniscus, Idotea, Limnoria.
6. *Amphipoda.*—Ex. Sandhoppers (Gammarus, Talitra), Spectre-shrimps (Caprella).
7. *Decapoda.*—Ex. Lobsters (Homarus), Shrimps (Crangon), Locust-shrimps (Squilla), Crabs (Cancer, Carcinus).

5. ARACHNIDA.—Respiration by lungs or tracheæ, or the gene-

ral surface; head and thorax united into a cephalo-thorax; antennæ absent; two pairs of jaws; legs, eight; abdomen without jointed appendages.

Orders of Arachnida.

1. *Pantopoda.*—Ex. Pychnogonum.
2. *Linguatulina.*—Ex. Pentastomum.
3. *Tardigrada.*—Ex. Bear animalcules (Macrobiotus).
4. *Acarina.*—Ex. Mites (Acarus), Itch mite (Sarcoptes), Demodex, Tics (Ixodes).
5. *Araneina.*—Ex. House spiders (Tegenaria), Field spiders (Epeira), Mason spiders (Cteniza).
6. *Arthrogastra.*—Ex. Scorpions (Scorpio), Book scorpions (Chelifer), Phrynus, Shepherd spiders (Phalangium).

6. Myriapoda. — Respiration by tracheæ; head distinct; remainder of the body divided into nearly similar segments; one pair of antennæ; legs, numerous.

Orders of Myriapoda.

1. *Chilognatha.*—Ex. Millepedes (Julus, Glomeris).
2. *Chilopoda.*—Ex. Centipedes (Scolopendra).

7. Insecta. — Respiration by tracheæ; head, thorax, and abdomen distinct; one pair of antennæ; legs, six, borne on the thorax; abdomen destitute of legs; mostly two pairs of wings on the thorax.

Orders of Insecta.

1. *Anoplura.*—Ex. Lice (Pediculus).
2. *Malophaga.*—Ex. Bird-lice (Philopterus).
3. *Thysanura.*—Ex. Springtails (Podura).
4. *Rynchota.*—Ex. Plant-lice (Aphis), Cicada, Cochineal Insect (Coccus), Boat-flies (Notonecta), Field-bugs (Pentatoma, Rhopalus), Bed-bugs (Cimex).
5. *Orthoptera.*—Ex. Locusts (Locusta), Grasshoppers (Gryllus), Crickets (Acheta), Walking-leaves (Phyllium), Cockroaches (Blatta), Earwigs (Forficula).
6. *Neuroptera.*—Ex. White Ants (Termes), May-flies (Ephemera), Dragon-flies (Libellula), Ant-lions (Myrmeleo), Stone-flies (Phryganea).

7. *Aphaniptera.*—Ex. Fleas (Pulex).
8. *Diptera.*—Ex. Forest-flies (Hippobosca), House-flies (Musca), Gnats (Culex).
9. *Lepidoptera.*—Ex. Butterflies (Vanessa, Pontica), Moths (Bombyx, Deilephila).
10. *Hymenoptera.*—Ex. Bees (Apis, Bombus), Wasps (Vespa), Ants (Formica), Ichneumons (Microgaster, Ichneumon), Gall-flies (Cynips), Saw-flies (Tenthredo).
11. *Strepsiptera.*—Ex. Stylops.
12. *Coleoptera.*—Ex. Lady-birds (Coccinella), Turnip-flies (Haltica), Capricorn-beetles (Cerambyx), Weevils (Curculio), Blister-beetles (Lytta), Spring-beetles (Elater), Stag-beetles (Lucanus), Cockchafers (Melolontha), Water-beetles (Ditiscus), Tiger-beetles (Cicindella).

Geological distribution of the Annulosa.

V.

MOLLUSCA.

Animal, composed of a single right and a single left merosome, a determinable median antero-posterior and dorso-ventral plane.

The Mollusca may be primarily divided into the two following Series:—

1. Molluscoida.—Central nervous system, consisting of a single ganglion, or of a principal pair with accessory ganglia; heart very imperfect, consisting of a simple open tube, or entirely absent.

2. Mollusca (proper).—Central nervous system, consisting of three principal pairs of ganglia; heart always well developed, and presenting at least two chambers.

Under the Molluscoida are included the following three Classes:—

1. Polyzoa.—Alimentary canal suspended in a double-walled sac, from which it may be partly protruded by a process of evagination, and into which it may again be retracted by invagination; mouth surrounded by a circle or crescent of hollow ciliated tentacles; animals always forming composite colonies.

Orders of Polyzoa.

1. *Gymnolœmata.*—Ex. Sea mats (Flustra), Gemellaria, Eschara, *Ptilopora, *Fenestrella.
2. *Phylactolœmata.*—Ex. Plumatella, Fredericella.

2. TUNICATA.—Alimentary canal suspended in a double-walled sac, but not capable of protrusion and retraction; mouth opening into the bottom of a respiratory sac, whose walls are more or less completely lined by a network of blood-vessels.

Orders of Tunicata.

1. *Ascidioidea.*—Ex. Ascidia, Botryllus.
2. *Salpinæ.*—Ex. Salpa.

3. BRACHIOPODA.—Body included within a bivalve shell, which is lined by a mantle; mouth opening at the base of two long cirriferous arms.

Orders of Brachiopoda.

1. *Terebratulinæ.*—Ex. Lamp-shells (Terebratula), *Spirifera, *Orthis.
2. *Discininæ.*—Ex. Discina.
3. *Cranianinæ.*—Ex. Crania.
4. *Lingulinæ.*—Ex. Lingula.

Under the Mollusca (Proper) are included the remaining four Classes of the Mollusca:—

4. LAMELLIBRANCHIATA.—Animal, without distinctly differentiated head; included in a bivalve shell; two lamelliform gills on each side of the body.

Orders of Lamellibranchiata.

1. *Asiphonidæ.*—Ex. Oyster (Ostræa), Scallop (Pecten), Mussel (Mytillus), *Gryphæa, *Gervillia, *Inoceramus.
2. *Siphonida.*—Ex. Cockle (Cardium), Razor-fish (Solen), Mya, *Diceras, *Hippurites, *Megalodon.

5. GASTEROPODA.—Animal with a distinctly differentiated head; never included in a bivalve shell; locomotion effected by means of a broad horizontally-flattened ventral disc, or by a vertically-flattened ventral fin-like organ.

Orders of Gasteropoda.

1. *Branchifera.*—Ex. Whelks (Buccinum), Cowries (Cy-

præa), Limpets (Patella), *Nerinæa, *Euomphalus, *Pleurotomaria, *Murchisonia.

2. *Pulmonifera.*—Ex. Snails (Helix), Slugs (Limax).

6. PTEROPODA. — Animal with a wing-like appendage for swimming, on each side of the anterior end of the body.

Orders of Pteropoda.

1. *Thecosomata.*—Ex. Hyalea, Cleodara, *Theca, *Conularia.
2. *Gymnosomata.*—Ex. Clio, Pneumoderma.

7. CEPHALOPODA.—Animal with eight or more arms in a circle round the mouth; body enclosed in a muscular mantle-sac; two or four plume-like gills within the mantle; an anterior tubular orifice (funnel) through which the effete water of respiration is expelled.

Orders of Cephalopoda.

1. *Tetrabranchiata.*—Ex. Nautilus, *Orthoceras, *Ammonites, *Scaphites.
2. *Dibranchiata.*—Ex. Cuttlefishes (Sepia, Loligo), Paper nautilus (Argonauta), *Geoteuthis, *Belemnites, *Belemnoteuthis.

Geological distribution of the Mollusca.

VI.

VERTEBRATA.

Animals composed of numerous merosomes, which are disposed in zones along a longitudinal axis; a determinable median antero-posterior and dorso-ventral plane; neural and hæmal regions shut off from one another.

Demonstration of the *typical Vertebra*, and homology of the *Vertebrate skeleton.*

The Vertebrata are divisible into two primary Sections:—

1. BRANCHIATA.—Animal always provided at some period of its life with gills. No amnion or allantois.

2. ABRANCHIATA.—Animal never provided with gills at any period of its life. An amnion and allantois present in the embryo.

The Branchiate Vertebrates include the following two Classes:—

1. PISCES (Fishes).—Respiration by gills; heart with one auricle and one ventricle; blood cold, carried in an arterial condition from the gills to the body; limbs mostly present in the form of fins.

Orders of Fishes.

1. *Cirrostomi.*—Ex. Lancelet (Amphioxys).
2. *Cyclostomi.*—Ex. Hagfish (Myxine), Lamprey (Petromyzon).
3. *Malacopteri.*
   a. *Apodes.*—Ex. Eels (Murœnidæ).
   b. *Abdominales.*—Ex. Herrings (Clupeidæ), Salmons (Salmonidæ), Carps (Cyprinidæ).
   c. *Pharyngognathi.*—Ex. Scomberesocidæ (Saurypikes).
4. *Anacanthini.*—Ex. Cods (Gadidæ), Plaices (Pleuronectidæ).
5. *Acanthopteri.*
   a. *Pharyngognathi.*—Ex. Wrasses (Cyclo-labridæ).
   b. *Acanthopteri veri.*—Ex. Perches (Percidæ), Tree-climbers (Labyrinthobranchii), Mullets (Mugilidæ), Mackerels (Scomberidæ),* Semiophorus (Chætodontidæ).
6. *Plectognathi.*
   a. *Sclerodermi.*—Ex. File-fishes (Balistini).
   b. *Apleuri.*—Ex. Trunk-fishes (Ostraciontidæ), Globe-fishes (Gymnodontidæ).
7. *Lophobranchii.*—Ex. Sea horses (Hippocampidæ), Pipe-fishes (Syngnathidæ).
8. *Ganoidei.*
   a. *Lepidoganoidei.*—Ex. Lepidosteus and Polypterus (Salamandroidei), *Dipterus (*Dipteridæ), *Holoptychius and *Rhizodus (*Holoptychidæ), *Palæoniscus (*Palæoniscidæ).
   b. *Placoganoidei.*—Ex. Sturgeons (Sturionidæ), *Pterichthys, *Cephalaspis, *Coccosteus, *Pteraspis.
9. *Holocephali.*—Ex. Chimera and Callorynchus (Chimeridæ), *Edaphodus and *Elasmodus (*Edaphodontidæ).

10. *Plagiostomi.*
    a. *Cestraphori.*—Ex. *Hybodus (*Hybodontidæ), Port Jackson sharks, *Cochliodus, *Acrodus, and *Ptychodus (Cestraciontidæ).
    b. *Selachii* (Sharks).—Ex. *Carcharodon and true sharks (Carcharidæ), Dog-fishes (Scilliadæ), Piked-dogs (Spinacidæ), Hammer-headed sharks (Zygænidæ).
    c. *Batides* (Rays).—Ex. Saw-fishes (Pristidæ), Electric Rays (Torpedinidæ), Skates (Raiidæ).
11. *Protopteri.*—Ex. Mud-fish (Lepidosiren).

Geological distribution of Fishes.

2. Amphibia (Frog-like animals).—Respiration at first exclusively by gills, afterwards partly or entirely by lungs, which are associated with a heart having two auricles and one ventricle; aorta containing a mixture of arterial and venous blood; two occipital condyles.

Orders of Amphibia.

1. **Ganocephala.*—Ex. Archegosaurus, Denderpeton.
2. **Labyrinthodonta.*—Ex. Labyrinthodon.
3. *Apoda.*—Ex. Cæcilia.
4. *Amphipneusta.*—Ex. Siren, Proteus, Siredon.
5. *Urodela.*—Ex. Water-neuts (Triton), Land-neuts (Salamandra).
6. *Anura.*—Ex. Surinam toads (Pipidæ), Toads (Bufonidæ), Frogs (Ranidæ).

Geological distribution of Amphibia.

The Abranchiate Vertebrates include the following three Classes:—

3. Reptilia (Reptiles).—Respiration never by gills; heart with two auricles and a more or less completely divided ventricle; aorta carrying a mixture of arterial and venous blood; a single occipital condyle.

Orders of Reptilia.

1. *Ophidia.*—Ex. Vipers (Vipera, Pelias), Rattlesnakes (Crotalus), Common snakes (Coluber), Pythons (Python).
2. *Sauria.*—Ex. Lizards (Lacerta), Iguanas, Dragons (Draco), Chameleons (Chameleo), *Mosasaurus, *Protorosaurus, *Thecodontosaurus.

3. *Loricata.*—Ex. Crocodiles (Crocodilus), *Teleosaurus.
4. **Enaliosauria.*—Ex. Ichthyosaurus, Plesiosaurus.
5. **Deinosauria.*—Ex. Iguanodon, Megalosaurus.
6. **Pterosauria.*—Pterodactyle (Pterodactylus).
7. *Chelonia.*—Ex. Turtles (Chelone), Tortoises (Testudo), *Colossochelys.

Geological distribution of the Reptilia.

4. AVES (Birds).—Respiration by lungs; bronchial tubes opening on the surface of the lungs into air-sacs; heart with two auricles and two ventricles; blood warm, blood corpuscles nucleated, arterial and venous blood never mixed; thoracic and abdominal cavities not separated by a draphragm; pectoral limbs in the form of wings; body covered with feathers; a single occipital condyle; animals oviparous.

Orders of Birds.

1. *Natatores* (Swimmers).—Ex. Penguins (Sphenicidæ), Auks (Alcidæ), Divers (Colymbidæ), Pelicans and Cormorants (Pelecanidæ), Gulls (Laridæ), Petrels (Procellaridæ), Ducks (Anatidæ).
2. *Grallatores* (Waders).—Ex. Rails and Water-hens (Rallidæ), Snipes, Sand-pipers, and Curlews (Scolopacidæ), Herons, Storks, and Spoonbills (Ardeidæ), Plovers (Charadriidæ), Bustards (Otididæ), Cranes (Gruidæ).
3. *Cursores* (Runners).—Ex. Ostriches, Emeus, and Cassowaries (Struthionidæ), Apteryx, *Deinornis, and *Palapteryx (Apterygidæ), *Epiornis.
4. *Rasores* (Scratchers).
   a. *Clamatores.*—Ex. Grouse and Ptarmigans (Tetraonidæ), Pheasants, Peafowl, Turkeys, and Common Fowl (Phasianidæ).
   b. *Gemitores.*—Ex. Ground-pigeons (Gouridæ), Doves (Columbidæ), *Dodo.
5. *Scansores* (Climbers).—Ex. Tucans (Ramphastidæ), Cuckoos (Cuculidæ), Woodpeckers (Picidæ), Parrots (Psitacidæ).
6. *Insessores* (Perchers).
   a. *Dentirostres.*—Ex. Shrikes (Laniidæ), Fly-catchers (Muscicapidæ), Thrushes, Blackbirds, Orioles, and Water-ousels (Turdidæ), Wagtails, Robins, and Nightingales (Sylvidæ).

b. Conirostres.—Ex. Crows, Magpies, and Jays (Corvidæ), Birds of Paradise (Paradiseidæ), Starlings and Bowerbirds (Sturnidæ), Finches, Buntings, Sparrows, Larks, Grosbeaks, and Weaver-birds (Fringillidæ).

c. Tenuirostes.—Ex. Creepers, Wrens, Lyre-birds, and Nut-hatches (Certhidæ), Honey-eaters (Meliphagidæ), Humming birds (Trochilidæ), Sun-birds (Promeropidæ), Hoopoes (Upupidæ).

d. Fissirostres.—Bee-eaters(Meropidæ),King-fishers (Alcedenidæ), Trogons (Trogonidæ), Rollers (Coracidæ), Swallows (Hirundinidæ), Swifts (Cypselidæ), Goatsuckers (Caprimulgidæ).

7. *Raptores* (Birds of prey).

a. Nocturnes.—Ex. Owls (Strigidæ),

b. Diurnes.—Ex. Hawks and Eagles (Falconidæ), Vultures (Vulturidæ).

Geological distribution of Birds.

5. MAMMALIA (Mammals).—Respiration by lungs; terminations of bronchial tubes never connected with air-sacs; heart with two auricles and two ventricles; blood warm, blood corpuscles non-nucleated, arterial and venous blood never mixed; thoracic and abdominal cavities separated from one another by a diaphragm; two occipital condyles; animals viviparous, nourishing their young with milk secreted in mammary glands.

The Mammalia are divisible into two primary Sections:—

1. IMPLACENTALIA.—No placental connection between the fœtus and the mother, the young being brought forth in a premature state of development; corpus callosum or great commissure of the brain very imperfectly developed.

2. PLACENTALIA.—Young before birth connected by a placenta with the mother, and brought forth in a comparatively advanced stage of development; corpus callosum well developed.

Under the Implacental Mammals are included the following two Orders:—

1. *Montremata.*—This order contains only two genera, Ornithorynchus and Echidna.

2. *Marsupialia.*—Ex. Wombats (Phascolomydæ), Kangaroos (Macropidæ), Phalangers (Phalangistidæ), Opossums (Didelphidæ), Pouched Wolf and Tasmanian Devil (Dasyuridæ), *Amphitherium, *Phascolotherium, *Diprotodon, *Microlestes.

The Placental Mammals include the remaining eleven Orders:—

3. *Cetacea.*
   - *a. Cete.*—Ex. True whales (Balenidæ), Sperm whales (Physeteridæ), Dolphins and Narwals (Delphinidæ).
   - *b. *Zeuglodontes.*—Ex. Zeuglodon.
   - *c. Sirenia.*—Ex. Sea cows (Manatidæ), *Rhitina.
4. *Pachydermata.*
   - *a. Anisodactyla.*—Ex. Elephants, *Mammoths, and *Mastodons (Elephantidæ), Tapirs (Tapiridæ), Hippopotamus (Hippopotamidæ), Rhinoceros (Rhinoceridæ), *Deinotherium, *Palæotherium, *Anoplotherium.
   - *b. Zygodactyla.* —Ex. Hogs and Peccaries (Suidæ).
   - *c. Lamnunguia.*—Ex. Hyrax (Hiracidæ).
5. *Solidungula.*—Ex. Horse, Ass, and Zebra (Equidæ).
6. *Ruminantia.*
   - *a. Tylopoda.*—Ex. Camels and Llamas (Camelidæ).
   - *b. Devexa.*—Ex. Giraffe (Camelopardalidæ).
   - *c. Cervina.*—Ex. Musk Deer (Moschidæ), Stags, Elks, *Megaceros, and Reindeer (Cervidæ).
   - *d. Cavicornia.*—Ex. Antelopes, Goats, Sheep, and Oxen (Bovidæ).
7. *Edentata.*
   - *a. Vermilinguia.*—Ex. Ant-eaters (Myrmecophagidæ), *Macrotherium.
   - *b. Cingulata.* — Ex. Armadillos (Dasypodidæ), *Glyptodon.
   - *c. Tardigrada.*—Ex. Sloths (Bradypodidæ), *Mylodon, *Megatherium.
8. *Rodentia.*—Ex. Hares (Leporidæ), Capybaras, Agoutis and Guinea-pigs (Cavidæ), Porcupines (Histricidæ), Beavers (Castoridæ), Mice, Rats, Voles, Hamsters, and Lemmings (Muridæ), Jerboas (Dipodidæ), Squirrels and Marmots (Sciuridæ).
9. *Carnivora.*—
   - *a. Pinnigrada.*—Ex. Seals and Sea lions (Phocidæ), Walrus (Trichecidæ).
   - *b. Plantigrada.*—Ex. Bears (Ursidæ), Badgers (Melidæ), *Amphicyon.

c. *Digitigrada.*—Ex. Dogs, Wolves, and Foxes (Canidæ), Cats, Tigers, and Lions (Felidæ), Hyænas (Hyænidæ), Civets (Viverridæ). Weasels and Otters (Mustelidæ), *Hyænodon,

10. *Insectivora.*—Ex. Moles (Talpidæ), Shrews (Soricidæ), Hedgehogs (Erinacidæ).

11. *Cheiroptera.*—Ex. Common bats (Vespertilionidæ), Horse-shoe bats (Rhinolophidæ), Vampires (Phyllostomidæ), Roussettes (Pteropodæ).

12. *Quadrumana.*—

a. *Prosimiæ.*—Ex. Flying lemurs (Galeopithecidæ), Aye-ayes (Chiromydæ), Lemurs (Lemuridæ).

b. *Simiæ.*

New World Monkeys.

1. *Platyrhinæ.*—Ex. Marmosets (Hapalidæ), Sajous, Spider monkeys, and Howling monkeys (Cebidæ).

Old World Monkeys.

2. *Catarhinæ.*—Ex. Macacos, Baboons, Orangs, Gorillas and Chimpanzees (Simiidæ).

13. *Bimana.*—Man.

Geological distribution of the Mammalia.

GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

The conditions of life.

The conditions of life not uniformly distributed over the Earth.

Distribution of heat.

Distribution of light.

Distribution of moisture.

Influence of variations in the distribution and intensity of heat, light, and moisture, on the organisation and habits of animals.

Necessity of a definite geographical distribution of organic forms.

The area of distribution.

Doctrine of distinct centres of creation.

The direction of distribution may be horizontal or vertical.
Horizontal and vertical distribution of land animals.
Distribution of marine animals.
Zones of depth in the sea.
The great Zoo-Geographical Provinces.

ETHNOLOGY.

I.

Man as distinguished from the lower animals.

1. His bimanal characteristics.
2. His adaption to an erect attitude.
3. Cerebral and cranial characteristics.
4. Psychical endowments.

II.

The various races of man compared with one another.

1. Anatomical differences.

a. Differences in the form of the cranium.

The Dolichocephalic cranium.
The Brachycephalic cranium.
The Prognathic, Pyramidal, and Elliptical crania.

b. Other Anatomical differences.

2. Physiological differences.
3. Psychological differences.

Consideration of the question whether the differences between the various races of man are entitled to rank as specific, or only as varietal distinctions.

III.

Geographical distribution of man.

IV.

Distribution of man in time.

GEOLOGY.

The sphere and objects of Geology.
Meaning of the term "Rock." Rock as distinguished from "Mineral."

All rocks have not been formed *in the same way.*

All rocks have not been formed *at the same time.*

Rocks, therefore, admit of classification. 1. According to their *modes of formation.* 2. According to their *relative ages.*

Rocks may be divided in accordance with their modes of formation into the following three great groups :—

1. AQUEOUS Rocks = Rocks whose formation is solely due to the action of water. Example, *Chalk, Sandstones.*
2. IGNEOUS Rocks = Rocks whose formation is solely due to the action of fire. Example, *Granite, Basalt.*
3. METAMORPHIC Rocks = Rocks which have undergone change by the action of some agency operating since their original formation. Example, *Gneiss.*

AQUEOUS ROCKS.

Evidence of Aqueous action in the formation of Rocks. *Stratification, Fossil contents.*

Aqueous Rocks may have been formed either in the sea or in fresh water, or under the influence of both.

The present occurrence above the level of the sea of Rocks which must have been formed below it, due entirely to the operation of *elevating forces.*

Proofs of the present existence of such forces.

Original *horizontality* of strata.

Vertical and *Inclined* strata—*Contortions.*

Dip and Strike.

Anticlinal and *Synclinal* curves.

Unconformable Stratification.

Joints.

Slaty Cleavage.

Faults—Influence of faults in the art of mining.

Denudation—Its vast amount.

Instances of *Ancient Sea-beaches,* now found far inland, and the explanation of this phenomenon.

The crust of the earth viewed with regard to the *successive periods of time* which have elapsed during its formation.

Three principal tests by which we judge of the relative ages of two given sets of strata.

1. *Superposition.*
2. *Mineral Character.*
3. *Organic Succession.*

The great Geological periods, arranged according to their succession, and grouped under three more comprehensive epochs.

I. PALÆOZOIC, OR PRIMARY EPOCH.	1. Præ-cambrian. 2. Cambrian. 3. Silurian. 4. Devonian. 5. Carboniferous. 6. Permian.
II. MESOZOIC, OR SECONDARY EPOCH.	7. Triassic. 8. Jurassic or Oolitic. 9. Cretaceous.
III. KAINOZOIC, OR TERTIARY EPOCH.	10. Eocene. 11. Miocene. 12. Pliocene. 13. Pleistocene. 14. Recent.

The following list contains some of the Genera which may be regarded as representing the life of each of the great Geological periods.

The Genera which have become extinct are marked with an asterisk.

I.

PALÆOZOIC, OR PRIMARY EPOCH.

1. Præ-cambrian.

A Rhizopod, **Eozoon canadense*, is the only fossil hitherto detected in Præ-cambrian rocks.

2. Cambrian.

Obscure *fucoid* impressions; **Oldamia* an organism of doubtful affinity, probably hydroid; burrows and tracks of *annelides*; possibly tracks of mollusca; and **Palæopyge*, a doubtful trilobite form, constitute the sole evidence of the life of the Cambrian period.

3. Silurian.

a. Lower Silurian.

Plants.—Fucoids (*Cruziana, *Chondrites).

Rhizopoda.—*Graptolites (*Didimograpsus, *Diplograpsus, *Rasirities).

Spongiæ.—*Palæospongia.

Actinozoa.—*Favosites, *Heliolites, *Petraia, *Syringophora.

Echinodermata.—*Cystoidea (*Hemicosmites, *Spheronites), *Palæaster, *Protaster.

Annelida.—*?Tentaculites, *?Nereites.

Crustacea.—*Trilobites (*Olenus, *Agnostus, *Asaphus, *Trinucleus, *Illænus, *Phacops).

Polyzoa.—*Fenestrella.

Brachiopoda.—Lingula, *Atrypa, *Orthis.

Lamellibranchiata.—*Modiolopsis, Modiola, *Pterinæa, *Ctenodonta, Nucula.

Gasteropoda.—*Holopæa, *Enomphalus, *Murchisonia, *Bellerophon.

Pteropoda.—*Conularia, *Theca.

Cephalopoda.—*Orthoceras, *Lituites, *Cyrtoceras.

b. Upper Silurian.

Rhizopoda.—*Graptolites (*Graptolithus).

Spongiæ.—*Stromatopora.

Actinozoa.—*Cyathophyllum, *Petraia, *Acervularia, *Alveolites, *Halysites, *Favosites.

Echinodermata.—Crinoidea (*Pseudocrinites, *Echinoencrinites, *Crotalocrinus, *Cyathocrinites, *Periechocrinus), *Palæaster, *Protaster, *Palæocoma.

Annelida.—*?Cornulites, *?Tentaculites, *Serpulites.

Crustacea.—*Trilobites (*Phacops, *Acidaspis, *Calymene, *Homalonotus, *Illænus), *Beyrichia, *Eurypterus, *Pterygotus.

Polyzoa.—*Fenestrella, *Ptylodictyon.

Brachyopoda.—*Atrypa, *Rynchonella, *Orthis, *Strophonema, *Pentamerus, *Spirifera.

Lamellibranchiata.—Avicula, *Pterinæa, *Modiolopsis, *Ctenodonta.

Gasteropoda.—*Euomphalus, *Murchisonia, *Holopella, Natica, Turbo, *Bellerophon.

Pteropoda.—*Conularia, *Theca.

Cephalopoda.—*Orthoceras, *Lituites, *Cyrtoceras, *Phragmoceras, Nautilus.

Fishes.—Remains of fishes, only in the later part of the period, *Onchus, *Sphagodus, *Plectrodus, *Cephalaspis, *Pteraspis.

4. Devonian.

Plants.—Fucoids (*Chondrites, *Zosterites), Vascular Cryptogamia (*Adiantites, *Calamitoides, *Lepidodendroides).

Spongiæ.—*Stromatopora.

Actinozoa.—*Cyathophyllum, *Arachnophyllum, *Heliolites, *Pleurodictyum.

Echinodermata.—Crinoidea (*Cupressocrinus, *Cyathocrinus, *Actinocrinus).

Annelida.—Tracks and burrows of sea-worms.

Crustacea.—*Trilobites (*Bronteus, *Phacops), Estheria, *Pterygotus, *Eurypterus, *Stylonurus.

Brachyopoda.—*Spirifera, *Atrypa, *Orthis, *Calceola, *Stryngocephalus, *Uncites.

Lamellibranchiata.—Avicula, Corbula, Modiola, *Megalodon, Anodon.

Gasteropoda.—*Pleurotomaria, *Euomphalus, *Murchisonia.

Cephalopoda.—*Orthoceras, *Clymenia, *Goniatites.

Fishes.—*Cephalaspis, *Coccosteus, *Pterichthys, *Asterolepis, *Dipterus.

5. Carboniferous.

Plants.—Ferns (*Sphenopteris, *Pecopteris, *Neuropteris), *Lepidodendron, *Sigillaria, *Calamites, *Sphenophyllum, *Asterophyllum, *Knorria.

Foraminifera.—*Fusulina.

Actinozoa.—*Cyathophyllum, *Lithostrotion, *Syringopora, *Michelinia.

Echinodermata.—Crinoids (*Actinocrinus, *Cyathcrinus, *Poteriocrinus, *Platycrinus, *Pentatremites), *Archæocydaris, *Palæchinus.

Annelida.—Serpula, *Microconchus.

Crustacea.—*Trilobites (*Griffithides, *Phillipsia), Cypris, Cypridina, *Dithyrocaris, *Bellenurus.

Arachnida.—*Cyclophthalmus.

Insecta.—Corydalis.

Polyzoa.—*Fenestrella, *Ptilopora.

Brachyopoda.—*Producta, *Spirifera, Rynchonella, *Orthis, Terebratula.

Lamellibranchiata.—*Aviculopecten, *Conocardium, *Posidonomya, *Anthracosia.

Gasteropoda.—*Euomphalus, Natica, *Pleurotomaria, *Bellerophon, Pupa.

Pteropoda.—*Conularia.

Cephalopoda.—Nautilus, *Orthoceras, *Goniatites.

Fishes.—*Rhizodus, *Megalichthys, *Platysomus, *Psamodos.

Amphibia.—*Archægosaurus.

6. Permian.

Plants.—Ferns (*Neuropteris, *Caulerpa, *Sphenopteris), *Calamites, *Equisetites, *Lepidodendron, *Nœgerathia, *Walchia.
Actinozoa.—*Polycœlia, *Calamophora.
Echinodermata.—*Cyathocrinites, *Archæocydaris.
Annelida.—Spirorbis.
Crustacea.—*Dithyrocaris, Cythere. [The Trilobites have now become extinct.]
Polyzoa.—*Fenestrella, *Synocladia.
Brachiopoda.—*Producta, *Camarophoria, *Strophalosia.
Lamellibranchiata.—Avicula, Mytillus, *Bakevellia, *Schizodus.
Gasteropoda.—Natica, *Pleurotomaria.
Cephalopoda.—Nautilus.
Fishes.—*Palæoniscus, *Platysomus, *Cœlacanthus.
Reptilia.—*Protorosaurus, *Palæosaurus, *Thecodontosaurus.

II.

MESOZOIC OR SECONDARY EPOCH.

7. Triassic.

Plants.—Ferns (*Pecopteris, *Neuropteris, *Tæniopteris), *Equisetites, *Calamites, Cycads (*Pterophyllum), *Voltzia.
Echinodermata.—*Encrinus, Ophiura.
Crustacea.—Estheria.
Brachiopoda.—Terebratula, *Koninckia.
Lamellibranchiata.—*Gervillia, *Myophoria, Plagiostoma, Trigonia, Avicula.
Gasteropoda.—Turritella, Trochus.
Cephalopoda.—Nautilus, *Ceratites, *Ammonites.
Fishes.—*Acredus, *Hybodus, *Saurichthys.
Amphibia.—*Labyrinthodon.
Reptilia.—*Placodus, *Nothosaurus, *Rhyncosaurus, *Dicynodon, *Telerpeton.
Birds.—Footprints (*Brontozoum).
Mammalia.—*Microlestes, *Dromatherium.

8. Jurassic.

Plants.—Ferns (*Sagenopteris, *Pachypteris, *Tæniopteris), Equisetum, *Palæozamia, *Cycadeoidea, *Pterophyllum, *Thuytes, *Dammarites.

Rhizopoda.—Spirilina, Nodosaria.

Actinozoa.—*Trochocyathus, *Thecosmilia, *Montlivaltia, *Isastræa, *Thamnastræa.

Echinodermata. — Crinoids (*Extracrinus, *Apiocrinus), Ophioderma, Diadema, *Hemicidaris, *Acrosalenia.

Annelida.—Serpula.

Crustacea.—Cirriped (Polliceps), Cypridea, Estheria, *Archæoniscus, *Glyphæa, *Eryon.

Insecta.—Æshna, *Bupreston, Carabus.

Brachiopoda.—*Leptæna, Rhynchonella, *Spirifera, Terebratula.

Lamellibranchiata.—Avicula, *Gryphæa, Ostræa, Pecten, Lima, Pholadomya, Trigonia, *Gervillia, *Myacites, Astarte, Cardium, Cyrena.

Gasteropoda.—*Pleurotomaria, Chemnitzia, *Nerinæa, Cerithium, *Alaria, Paludina.

Cephalopoda.—*Geoteuthis, *Belemnites, *Belemnoteuthis, *Ammonites, Nautilus.

Fishes.—*Acrodus, *Hybodus, *Achmodus, *Dapedius, *Caturus.

Reptilia. — *Ichthyosaurus, *Plesiosaurus, *Pterodactylus, *Teleosaurus, *Goniopholis, *Pleurosternon.

Birds.—*Archæopteryx.

Mammalia.—*Amphitherium, *Phascolotherium, *Spalacotherium, *Plagiaulax, *Stereognathus.

9. Cretaceous.

Plants.—Ferns (*Lonchopteris), *Sphenopteris, Equisetum, *Clathraria, *Thuytes, *Abietites, *Endogenites.

Foraminiferæ.—Rotalina, Textularia, Dentalina, *Flabellina, Cristellaria, *Orbitoides.

Sponginæ.—*Siphonia, *Ventriculites, *Chenendopora, *Polypothecia, *Guettardia, *Choanites.

Actinozoa.—*Trochocyathus, *Parasmilia, Parastræa, *Micrabacia.

Echinodermata.—Crinoids (Pentacrinus, *Bourgueticrinus, *Marsupites), Cidaris, *Ananchites, *Galerites, *Salenia, Goniaster.

Crustacea.—Cypridea, Estheria, *Meyeria, *Notopocorystes.

Polyzoa.—*Actinopora, Retepora, Lunulites, Eschara.

Brachiopoda.—Terebratula, Rhynchonella, Crania.

Lamellibranchiata.—Lima, Pecten, Ostræa, *Exogyra, *Ino-

ceramus, Trigonia, Plicatula, Arca, Pectunculus, Cardium, Cyrena, Unio, *Diceras, *Hippurites, *Radiolites.

Gasteropoda.—Pteroceras, Rostellaria, Scalaria, Turritella, Natica, *Pleurotomaria, Melanopsis, Neritina, Paludina.

Cephalopoda. — *Belemnites, *Ammonites, *Ancyloceras, *Scaphites, *Hamites, *Baculites, *Turulites, Nautilus.

Fishes.—Lamna, *Ptychodus, *Pycnodus, *Lepidotus, *Macropoma, *Beryx, *Osmeroides.

Reptilia. — *Pterodactylus, *Iguanodon, *Megalosaurus, *Hylæosaurus, *Plesiosaurus, *Mosasaurus, Chelone, *Protemys.

III.

KAINOZOIC OR TERTIARY EPOCH.

10. Eocene.

Plants.—Chara, *Nipadites, *Wetherellia, *Legummosites.

Foraminiferæ.—Cristellaria, Rotalina, Dentalina, *Nummulites.

Actinozoa.—*Turbinolia, *Litharæa, Dendrophyllia.

Echinodermata.—Pentacrinus, Ophiura, Goniaster, Eupatagus.

Crustacea.—*Heploparia, *Zanthopsis.

Polyzoa.—Eschara.

Brachiopoda.—Lingula, Terebratula, Terebratulina.

Lamellibranchiata.—Ostræa, Pruna, Cryptodon, Cyrena, Pholadomya, Syndosmya, Arca, Chama, Teredo.

Gasteropoda.—Cerithum, Aporrhais, Cypræa, Voluta, Melania, Rostellaria, Strombus, Conus, Oliva, Mitra, Achatina, Bulimus.

Cephalopoda.—*Belosepia, *Beloptera, Nautilus.

Fishes.—Lamna, Myliobates, *Edaphodus.

Reptilia.—*Palæophis, Crocodilus, Chelone, Trionyx.

Birds.—*Halcyornis, *Lithornis.

Mammalia. — Didelphis, *Palæotherium, *Anoplotherium, *Dichodon, Macacus.

11. Meiocene.

Plants.—Leaves of Monocotyledonous, Coniferous, and Dycotyledonous Plants.

Foraminiferæ.—Amphistegina, Textularia.

Actinozoa.—Dendrophyllia, Astræa.

Polyzoa.—Lunulites, Retepora.

Lamellibranchiata.—Corbula, Venus, Arca, Pectunculus.

Gasteropoda.—Fusus, Murex, Cypræa, Oliva, Conus, Mitra.

Cephalopoda.—*Spirulirostra.

Fishes.—*Carcharodon.

Reptilia.—Crocodilus, *Colossochelys.

Mammalia.—*Zeuglodon, *Halitherium, *Dinotherium, *Mastodon, Elephas, Hippopotamus, *Macrotherium, *Amphicyon, *Driopithecus.

12. Pleiocene.

Foraminifera.—Operculina, Polymorphina.

Actinozoa.—Flabellum, Balanophyllia.

Echinodermata.—Comatula, Echinus, Echinocyamus.

Polyzoa.—Membranipora, Lepralia, Cellepora, Eschara, *Cupularia, Hornera, Pustulopora, *Alveolaria.

Brachiopoda.—Terebratula.

Lamellibranchiata.—Ostræa, Pecten, Astarte, Cardita, Cardium, Cyprina, Mactra.

Gasteropoda.—Bullæa, Voluta, Fusus, Purpura, Nassa, Natica.

Fishes.—*Semiophorus, Rhombus.

Mammalia.—*Balænodon, *Mastodon, Felis.

13. Pleistocene.

Plants.—Forests of Trees resembling those now living.

Lamellibranchiata.—Ostræa, Pecten, Astarte, Cardium, Cyprina, Cyrena, Mya, Mactra, Leda.

Gasterohoda.—Patella, Puncturella, Fusus, Litorina, Natica, Purpura, Turritella.

Birds.—*Deinornis, *Palapteryx.

Mammalia.—Elephas, Hippopotamus, Rhinoceros, *Megaceros, Cervus, *Urus, Bos, Ursus, Hyæna, Felis, *Mylodon, *Megatherium, *Glyptodon, *Diprotodon, Phascolomys.

14. Recent.

Characterised by existing forms, but more especially by the presence of Man.

The following, however, are among the higher animals which have become extinct since the appearance of Man.

? *Great Auk (*Alca impennis*).
*Dodo (*Didus ineptus*).
*Solitaire (*Pezophaps solitarius*).
*Moa (*Dinornis elephantopus*).
*Northern Manatee (*Rhitina stelleri*).

*Mammoth (*Elephas primigenius*).
*Woolly Rhinoceros (*Rhinoceros tichorhinus*).
*Irish Elk (*Megaceros Hibernicus*).
*Cave Bear (*Ursus spelæus*).
*Cave Hyæna (*Hyæna spelæa*).
*Cave Tiger (*Felis spelæa*).

Phenomena of *the Drift.*—Glacial Hypothesis.—Icebergs and Glaciers, their origin, structure, and motions.—Evidence of the ancient existence of Glaciers in the British Isles, and in other regions where they no longer occur.

Igneous Rocks.—Classification of Igneous Rocks.—Volcanoes, their structure and mode of action.—Active and Extinct Volcanoes.—Distribution of Volcanoes.—Earthquakes, and the Phenomena accompanying them.—Connection between Earthquakes and Volcanoes.

Trappean and Granitic Rocks.

Metamorphism.

THOMSONIAN LECTURES ON MINERALOGY.

[These Lectures are free to the Students of the General Course.]

The absence of organised structure and of physiological function renders the method of studying Minerals different from that practised in the study of Organic bodies.

Crystalline form.

Definition of a Crystal as *an inorganic solid bounded by plane surfaces symmetrically disposed, and deriving its figure from the forces exerted by its component molecules.*

Faces, Edges, Angles, and *Axes* of Crystals.

The multitude of crystalline forms admit of being reduced to *six great Types.*

Systems of Crystals.

1. Monometric or Cubical System.
2. Dimetric System.
3. Trimetric System.
4. Monoclinic System.
5. Triclinic System.
6. Hexagonal System.

I. The Monometric or Cubical System.

Its type, the *Cube.*

Its *Axes* are three; they intersect at right angles, and are equal to one another.

Forms referable to the Monometric system.

Derivation of Forms.
Crystallographic symbols.
Holohedral and *hemihedral* forms.
Law of *Symmetry* in Crystals.
Compound crystalline forms.

II. Dimetric System.

Its Type, the *Right Prism on a Square Base.*

Its *Axes* are three, intersecting at right angles, and one differs in length from the other two, which are equal to one another.

Forms referable to the Dimetric system.

III. Trimetric System.

Its type the *Right Prism on a Rectangular Base.*

Its *Axes* are three, intersecting at right angles, all unequal.

Forms referable to the Trimetric system.

IV. Monoclinic System.

Its Type, the *Oblique Prism, on a Rectangular Base.*

Its *Axes* are three in number, all unequal, only one at right angles to the other two.

Forms referable to the Monoclinic system.

V. Triclinic System.

Its Type, the *Oblique Prism, on an Oblique Parallelogram for its Base.*

Its *Axes* are three in number, all unequal; no one axis at right angles to another.

Forms referable to the Triclinic system.

VI. Hexagonal System.

Its Type the *Hexagonal Prism, on a Base which is a Regular Hexagon.*

Its *Axes* are four in number: the three lateral axes are equal to one another, and intersect one another at an angle of 60°.

Forms referable to the Hexagonal System.

Twin Crystals, or Macles.
Pseudomorphism.
Dimorphism.
Isomorphism.
Cleavage.

Determination of the *angles* of crystals. The *Goniometer.*
Theories of Crystallogeny.

Physical Properties of Minerals.

1. Properties dependent on the relation of Minerals to *light.*
   a. Double Refraction.
   b. Lustre, Colour, Diaphaneity.
2. Properties dependent on the degrees of *Cohesion.*
   a. Hardness.
   b. Tenacity.
   c. Fracture.
3. *Specific Gravity.*
4. *Phosphorescence, Electricity,* and other *physical* relations of Minerals.

Classification of Minerals.

Conception of a *Mineral species.*

Value of Chemical Composition as the basis of Mineralogical Classification.

Demonstrations of the more important Mineral species.

PRINTED BY NEILL AND COMPANY, EDINBURGH.